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The whole of human civilization has happened over the last ten thousand years. Since the end of the last Ice Age, we've gone from the Stone Age to the Nuclear Age.

All this has happened at a time, geologically speaking, of environmental and climatic stability. I don't think that's a coincidence. We have needed that stability to do what we've done, and we've had a very good run. We *Homo sapiens* have taken full advantage of the perfect conditions we've had. But geologically speaking, we are now entering a new era. It's been called the anthropocene, the age when humans have become major global players in how the planet functions at a global scale.

That globality, I think, is the critical thing in talking about civilization. We are now talking about a global civilization. We've messed up our local environment, one way or another, from time to time. Often civilizations have come and gone as a result. We've destroyed rain forests, created deserts, and civilizations have gone down under that pressure. The difference now is that we are acting globally.

The nitrogen and the sulfur cycles, to name two, are definitely in our hands. Increasingly, the carbon cycle is, too. And with that comes climate. We have control over the global climate now, if we want it. Perhaps we have control even if we don't want it.

A big question, perhaps THE big question is this: how vulnerable is our current, global civilization to environmental disruption on the global scale? And in thinking about that, I'm going to focus on water, one of the most basic resources on which we rely.

The first known permanent human settlement was on the west bank of the River Jordan. Jericho was constructed nine thousand years ago, just as the Ice Age was fading. *Homo sapiens* began to cross it then, in the warmer, post-glacial world. The settlement was modest enough, about ten acres. It

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had a big defensive wall, a tower inside, and a few hundred people. And close by was a spring that was recorded in the Bible as Elisha's spring. That spring was the reason for Jericho's existence. The Book of Kings speaks about it. Elisha said, "Make this valley full of ditches. We shall not see winds. Neither shall we see rain. Yet that valley shall be filled with water." And the springs gushed into the ditches and they have distributed its waters to fill the orchards ever since. Jericho as a city, as a town, has been rebuilt and destroyed several times, but the spring and the farming it sustained has kept going.

The area around was vital to the development of modern farming as we know it today. It was probably the first place to cultivate wild grain. Six thousand years ago they were growing peas and beans and olives and vines and figs. And soon hills were carved into terraces that captured their own water from the rain. Today the spring still delivers water at the rate of 76 liters a second into small falls, as it has done for nine thousand years.

And the farms still grow crops there in what must be one of the longest-lasting and most durable agricultural systems anywhere in the world. By any stretch of the imagination, nine thousand years is a good long time to keep that going. During those thousands of years, many grander civilizations have come and gone in the Middle East, many of them based on apparently more sophisticated systems of catching and manipulating water.

These are places where Western civilization is deemed to have begun. Around seven thousand or so years ago, early Sumerians in the Fertile Crescent of modern day Iraq, constructed the first large irrigation systems using river water. They diverted water from the Tigris and the Euphrates down long canals, erecting earth defenses against spring floods. And they began to build great cities, like Ur and Urap where the first writing was produced and the first sciences developed.

It was a great and perhaps the *first* great civilization. But the Sumerian fields gradually became blighted. Bumper wheat harvests began to fail. Wheat gave way to barley. The barley, too, waned. The fields became barren. The civilizations foundered and the land returned to desert. When the British archaeologist, Sir Leonard Woolley, excavated Ur in the 1930s he was astounded at the contrast between the great civilization he was uncovering and the barren land around him.

He said that to those who have seen the Mesopotamian Desert, the evocation of the ancient world is well nigh incredible, so complete is the contrast between past and present. If Ur was an empire's capital and the land surrounding it was once a vast granary, why did the population dwindle to nothing and the very soil lose its virtue? Now, Woolley's successors believe they have solved this riddle. The problem seems to have been tiny amounts of salt coming down from the river and accumulating over centuries in the fields, eventually poisoning soils and crops.

Cuneiform tablets of nearly four thousand years ago describe a farm system in its death throes, recording black fields becoming white and plants

choked with salt. And that would explain why wheat, which was less tolerant of salt than barley, gave way first. So we see, perhaps, that manipulation of the rivers made the Sumerian cities but it destroyed them, too.

Salt chased civilization through Mesopotamia, you might say, as mercilessly as any barbarian horde. Perhaps historians concentrate too much on the barbarian hordes and too little on the environmental circumstances, which can predispose civilizations to being militarily overrun. What do these stories tell us? I think the lessons for modern times are certainly clear in the threat posed by salt.

There are plenty of societies, irrigated societies, where today we can see salt as a major problem. You have the Colorado River here in the United States, the Murray Basin in Australia or the Nile or the Indus or many other parts of the world. The farmers in any of these places will certainly talk to you about salt.

But the historians did something else that is, on the face of it, rather odd. Why cities? It is not obvious that these ancient, rich, agrarian societies should need them at all. And yet, they invented them. From Mesopotamia to the Nile, from the Indus to the Yellow River in China, a series of great civilizations grew up by irrigating arid areas from mighty rivers. And they all had cities.

One school of thought holds that cities were largely born because these agrarian societies needed new kinds of social organizations to collect, distribute, and contain the water on the large scale necessary in order to sustain those societies. They had to hire farmers or coerce slaves into digging and maintaining dykes and canals, watching out for floods.

They needed to develop scientific skills like astronomy and mathematics to predict nature's whims. The American historian Karl Wittfogel coined the phrase "hydraulic civilizations" to describe societies that are organized around the need to manage water. He argued that societies often required cities to do this. Not all academics agree, but it is an interesting interpretation of history. And it is certainly remarkable how many great civilizations emerged in environments where management of water, often a very scarce water, was the first priority. Wittfogel contended that until the industrial revolution, the majority of human beings lived within the orbits of hydraulic civilization. In the Americas at one time, three-quarters of the population, he said, lived in a few small centers of hydraulic civilization in Mexico and Peru. These were much the most productive areas on the planet.

In Europe, it was those arid areas that had to manage water that innovated and developed in other ways, too. So in the Middle Ages, Cordova, the capitol of Moorish Spain, sustained a population of more than a million people through irrigated agriculture, at a time when the largest city north of the Alps was London, which had a mere thirty-five thousand people — only a thirtieth as much.

And it was not just the desert civilizations of the ancient world that depended on the sophisticated management of water. One of the most

stupendous preindustrial civilizations centered around Kampot in Cambodia. The Khmer civilization rose around 8800, reached its height and crashed in the early fifteenth century. Its influence spread throughout Southeast Asia and its great capital was one of the true wonders of the world, set in the jungle at the head of a great lake. Angkor today is known for its temples.

But in the past five years researchers have revealed that civilization there was about much more than temples. They, too, were remaking their landscape. Again, water was at the heart of their work. The temples we see today were simply the ceremonial heart of a huge suburban landscape, which at its height was called by far, the most extensive, preindustrial city in the world. Rather like a modern day Las Vegas.

Satellite pictures show what is not visible from the ground, the remains of huge networks of canals, spreading out from the temple, linking reservoirs and rice paddies and ports and Angkor suburbs. Visitors to the Angkor temples today can still see huge moats and reservoirs dotted among the temples. And yet, huge as they are, they were really only baubles for the kings. The new evidence is that the workaday job of keeping the hundreds of thousands of Angkor inhabitants and fields watered was done by waterways connected to suburban pools and areas of rice paddies.

And it was this that underpinned the wealth of the rulers and their temples. And now the Khmer civilization, which is arguably the greatest that Southeast Asia has ever seen, eventually failed. What went wrong? The latest evidence points to an environmental catastrophe brought on by failure of the water supply. The reservoirs and the ponds and the canals and the paddy fields all drew their water from streams, draining from surrounding hills into the great lakes at the foot of the city.

The channels that collected the water and delivered it to the suburban complexes were beautifully built. Many of them were up to forty meters wide. But there were also artificial channels, and for that reason they were prone to break out of their allotted course. Over the centuries, one of them started to take more and more water, and as it did it grew and began to cut its bed ever lower. In the end, the channel became so low that it could no longer deliver water to the reservoirs and to the water distribution system.

That system was left high and dry. And that, more or less, is what happened to the civilization. There are many unanswered questions about the collapse of the Khmer civilization, and there will be different interpretations of the history of the evidence. But it is increasingly clear, I think, that just as management of water made that civilization, so, too, failures of management ultimately destroyed it.

What do we make of all these tales of collapse? Three things, I think. First, that resource adversity does breed innovation up to and including the invention of entirely new forms of civilization, like cities themselves. Second, that civilizations built on intensive use of water often find themselves highly vulnerable to climate change or to the insidious and destructive

elements in their own systems of water exploitation, like salt or like the eroding power of artificial water channels. They may contain the seeds of their own destruction.

And third, perhaps, that less intensive and less grand uses of water, such as those employed around Jericho, where we started, which have lasted so far for nine thousand years, can be more flexible in the face of change and so more long-lasting. Jericho never grew as big as the famous hydraulic civilizations around the Middle East. But while those civilizations fell long ago, farmers still make a living around Jericho, using traditional systems.

All this may offer a lesson for our management of water today. In our modern world we tend not to recognize environmental resource constraints. We believe in our ability to innovate and to solve problems. Maybe we are right. We have been quite successful so far. Again, let's take water. America today is growing fastest in the West where water is in the shortest supply.

California and Arizona, long since ran out of the water locally, so they import it, mostly from the Colorado River. And their system works for now. They have water, plenty of it. But the great reservoirs on the Colorado are currently close to empty after a run of bad years. The crunch could be coming really very soon. Cities like Phoenix are, perhaps, living on borrowed time. They expect their water from the Colorado to keep going, and very soon it may not. And it will create big problems for many of the societies in the American West.

Faced with these growing kinds of shortages, which are really global in their extent, we are starting to move water around on an ever larger scale. If you look around the world you will see that in China you have the Three Gorges Dam. China has a much bigger project. It is spending $50 billion dollars to move water from the wet south of the country to the dry north, to the area around the Yellow River, to keep its agriculture going, to keep water for irrigation. That is necessary to feed a fifth of the planet.

India has a plan on its docks to spend 200 billion dollars, $200 billion, to move water from the wet north, the River Ganges and so on, to the dry south and the west. The Indians have not started the project yet, unlike the Chinese who are already underway. These are about the biggest engineering projects on the planet today, moving water around.

Libya has spent 25 billion dollars moving water from under the Sahara Desert, pumping it up and sending it to coastal farms. In Africa they are talking about moving water from the River Congo in the jungle north to the edge of the Sahara Desert to refill Lake Chad, which is nearly empty. The Soviets, years ago, planned (and never began) to empty their great Siberian south to refill the Aral Sea. (One of the great environmental disasters of our time was the emptying of the Aral Sea.) I went there a couple of months ago as part of another project to see what had happened on the Aral Sea. I think if you ever want to see a society that is on the verge of collapse for want of water today, then that is where you need to go.

I went to Moynat, which used to be a fishing port and looked out from the promenade across what used to be the sea. One hundred kilometers away to the north was the nearest patch of sea. It was quite extraordinary to see something like that. No water was there because it had all been diverted from the rivers that supplied the sea, diverted for growing cotton as part of the great Soviet enterprise for providing cotton for the Soviet Empire.

But what struck me most — after all, the Soviet Empire is gone now — was the evidence all around of a society failing. Of course, the fishermen no longer had anything to fish. The farmers had no water to grow crops. The water had already been removed from the rivers, hundreds of miles to the south. The canal managers were still in their offices managing canals that had no water in them, which is bizarre.

They've had famine there in the last few years, but there is worse, because the arid sea is producing huge dust storms, as the sand is blown off the bottom of the sea. And that sand contains huge amounts of salt. In fact, the air is full of salt. And it is not just the air — the water, the food, the whole environment in the area around the Aral Sea is clogged with salt. And that is actually creating a pandemic, principally of anemia. Virtually everybody is sick. Ninety-eight percent of the population has anemia according to the figures provided by the doctors there.

People are leaving in very large numbers. They are environmental refugees, millions of them. Perhaps Samaria was like this in the end. Certainly it is the worst I have ever seen.

I began by talking globally. Climate change is threatening similar disruption. In Pakistan, where the River Indus is expected to lose much of its flow, the population did double in twenty-five years. In fifty years the River Indus may have only half the water it had previously because of climate change. There are going to be many other places like that as climate change gathers force.

This is a global problem, lack of water. So I come back to my original point. Human society has done well in times of environmental and climatic stability. But can we keep up? Past human society has responded to resource and environment problems like water shortages either by innovating or by dying. If we face a global crisis like lack of water and other resources because of climate change then, as a planet, we face a choice. Do we innovate or do we die?

We had a good run, as I said, for ten thousand years. But maybe we are bringing that to an end by our own devices. Now, I don't want to be too pessimistic. I am an optimist. I think we can and should find a way out. There are really no reasons why we shouldn't. The reasons are more political, I think, than anything else. But I must say, down on the shores of the Aral Sea, looking at the disaster there and wondering whether it might be repeated elsewhere, I did begin to wonder.

Climate